THE EFFECT OF ELECTRON BEAM IRRADIATION ON BALLPOINT PEN AND MARKER INKS

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INTRODUCTION

In the MAAFS Newsletter 30-3 for 2002, the authors presented some data on the effects of biological remediation agents on various inks. The note provoked some responses and suggestions especially concerning the effects of electron beam treatments as used by the post office to sterilize mail that passes through selected facilities. There seemed to be some concern about the differences in dose rates and total dosage between the experimentally electron irradiated inks and those irradiated when sent through the postal system. A series of experiments were set up to test the inks as they are actually irradiated by the postal system. Some of the suggestions from correspondents have been incorporated into this amplification of the previous note.

EXPERIMENTAL

Specimens of ballpoint pen and marker inks were prepared by applying writing on Whatman 1 paper. These were allowed to dry in the dark for several weeks to avoid the solubility problems encountered with freshly applied inks.

Electron beam irradiation for the non-postal samples was performed at 5.2 MeV at 250 microamps for a total dose of 257 kGy. This is 2 to 5 times the anticipated dose expected for letters sent through the postal system. The mailed specimens were sent first class through the postal system to an address in an area where all small postal items are known to be irradiated. The assumption can be made that the postal dose would be at least 30-40 kGy.

Thin layer chromatography (TLC) was performed as noted previously on silica gel 60 on glass plates. The solvent system used was n-butanol, absolute ethanol, deionized water 50:10:15 as described by Brunelle and Pro (1). Inks were extracted from the paper with acetone.

RESULTS

Electron irradiation of the ink specimens on Whatman paper did not show any perceptible differences in the ink colors on cursory examination. The paper turned yellow and became increasingly yellow with time. Table 1 lists the changes noted after TLC in specimens prepared to test the effects of irradiation during controlled tests at approximately 257 kGy as reported earlier. Table 2 lists the data from a follow up study to see whether similar problems occur with "real world" specimens irradiated during the postal delivery process.

TABLE 1

Samples Treated to 257 kGy Electron Irradiation	
Samples	Changes in Ink Components
Skilcraft US gov. fine, blue	new blue component
Skilcraft felt tip, blue	new blue component
Skilcraft marker, blue	new pink component
Skilcraft marker, red	new red component
Papermate med. pt., blue	new blue component
Bic round stic medium; blue	new blue component
Schwan stabilo; red	altered mobility of components

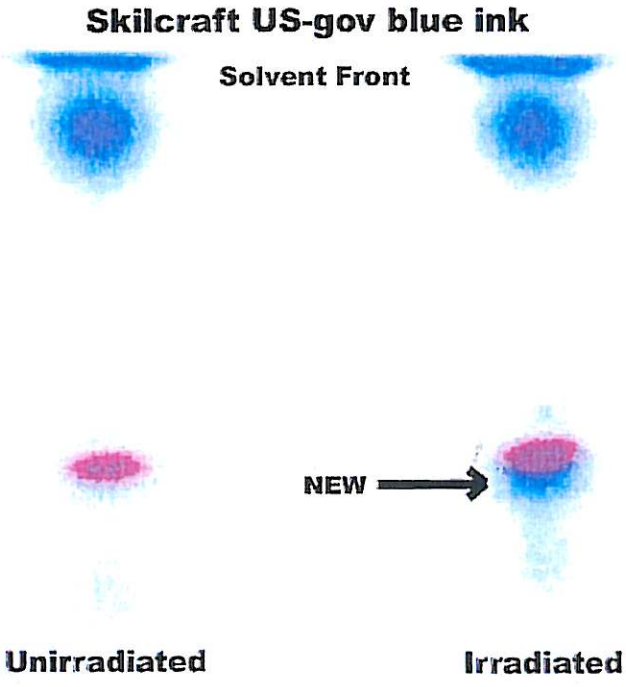

TABLE 2

Postal Irradiated Specimens Prepared Jan. 2003 and Postmarked March 22, 2003	
Samples	Changes in Ink Components
Bic round stic medium USA, blue	new blue component
Papermate med Pt, blue	new blue component
Schwan stabilo, red	altered mobilities
Skilcraft felt tip, blue	new blue component
Skilcraft US gov fine, blue	new blue component
Skilcraft, red	new component, altered mobilities
Skilcraft, blue	new pink component
Genovision Black: Bic wide body, Mexico	missing a component
Skilcraft US gov USA, blue	new blue component
Skilcraft US gov med, blue	new blue component
Vista by Skilcraft fine, black	new yellow spot

Bic Wide Body Mexico Black

Thin layer chromatography shows differences in a number of inked specimens resulting from irradiation. There are also differences between the postal and test irradiated specimens. It is not known whether the changes in the inks are due to the effects of high temperatures, ionizing radiation (dose or dose rate differences are possible), or a combination of both. It is known from other results (such as the melting of polystyrene slide holders and computer disk covers) that mail can reach temperatures of over 100 C during the postal irradiation process. Not only are there possible changes within the molecules of dyes from the heat and radiation but also changes caused by reaction with entities such as hydroxyl radicals formed in the paper. There are, however, unequivocal differences in some irradiated inks.

Two images were prepared and accompany this note. They document some of the possible problems in comparing ink specimens. The images were taken with a digital camera and processed through Photoshop software. The contrast was slightly improved for posting. The first image is of the thin layer chromatogram of postal irradiated and unirradiated inks from a Skilcraft US-gov blue pen. The image details a new blue component in the ink mixture not present originally. The second image is of the chromatogram from a Bic wide body pen (Mexico) and details the loss (or alteration) of a component after postal irradiation.

CONCLUSIONS

The forensic analysis of inks after electron beam treatment to remove biological hazards can present problems in interpretation. In some cases the presence of extra components of similar color to the original ink were detected. In other cases loss of components was noted. Altered mobilities with or without color change may account for some of these changes, but chemical changes leading to loss of color may also occur. Comparison of irradiated inks within an irradiated specimen may be suitable but comparison of irradiated and unirradiated specimens may be problematic.

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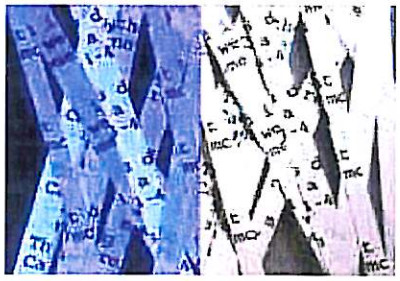
1. Brunelle, R. L. and M. J. Pro. "A Systematic Approach to Ink Identification", *Journal of the AOAC* (1972) 55(1):823-826.



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